

Searches for Physics Beyond the Standard Model at CDF Run II

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Outline

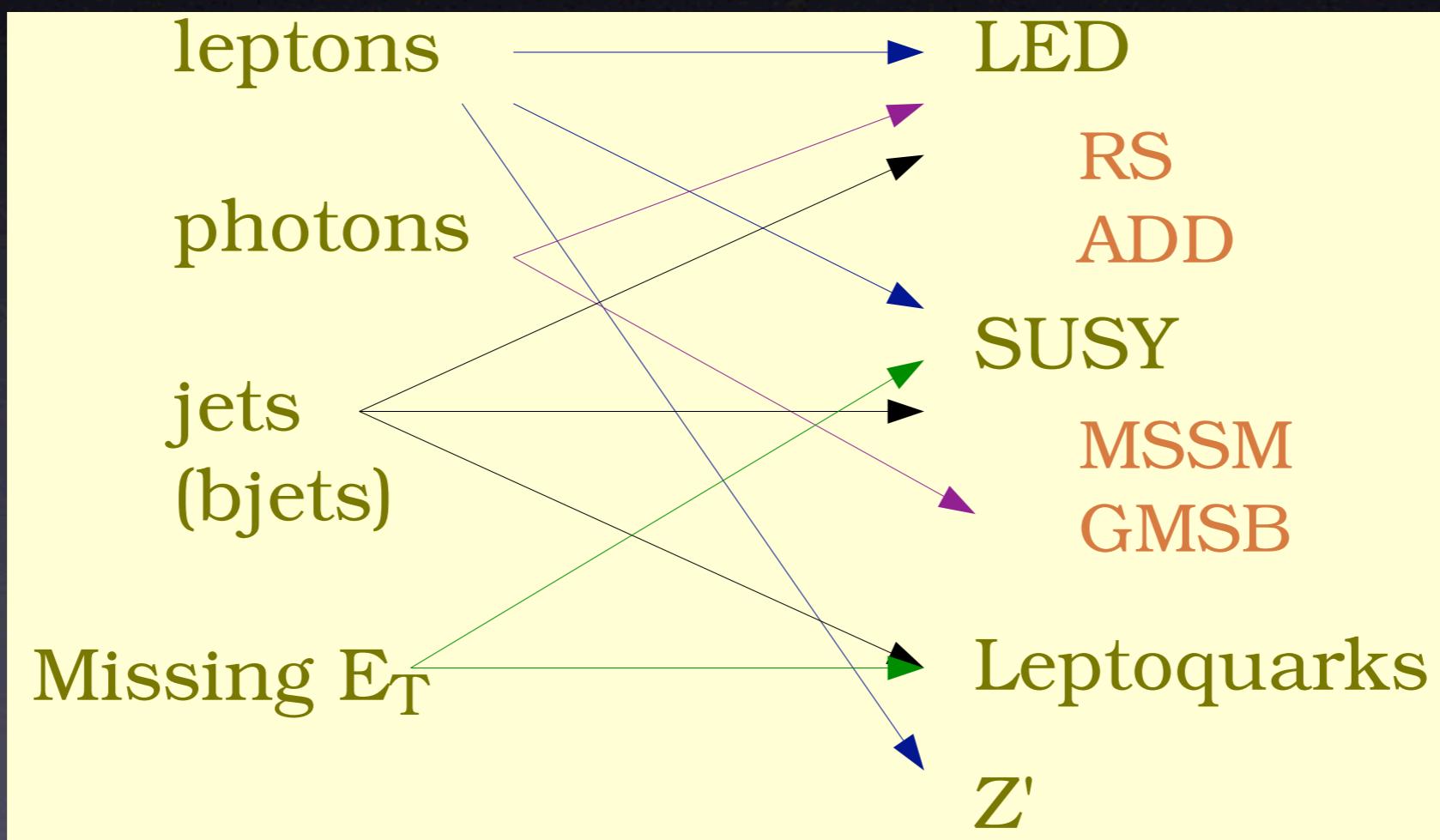
- Exotics domain and strategy
- Present CDF analyses
- Overview of other CDF Results
- Coming attractions

BSM: Subjects & Status

- Higgs: SM and SUSY (...and...)
- SUSY: SUGRA, RPV, GMSB,AMSB
- Leptoquarks
- Technicolor (little Higgs, etc...)
- Extra dimensions
- Heavy gauge bosons (Z' , W')
- Excited fermions

Beyond the SM: Strategy

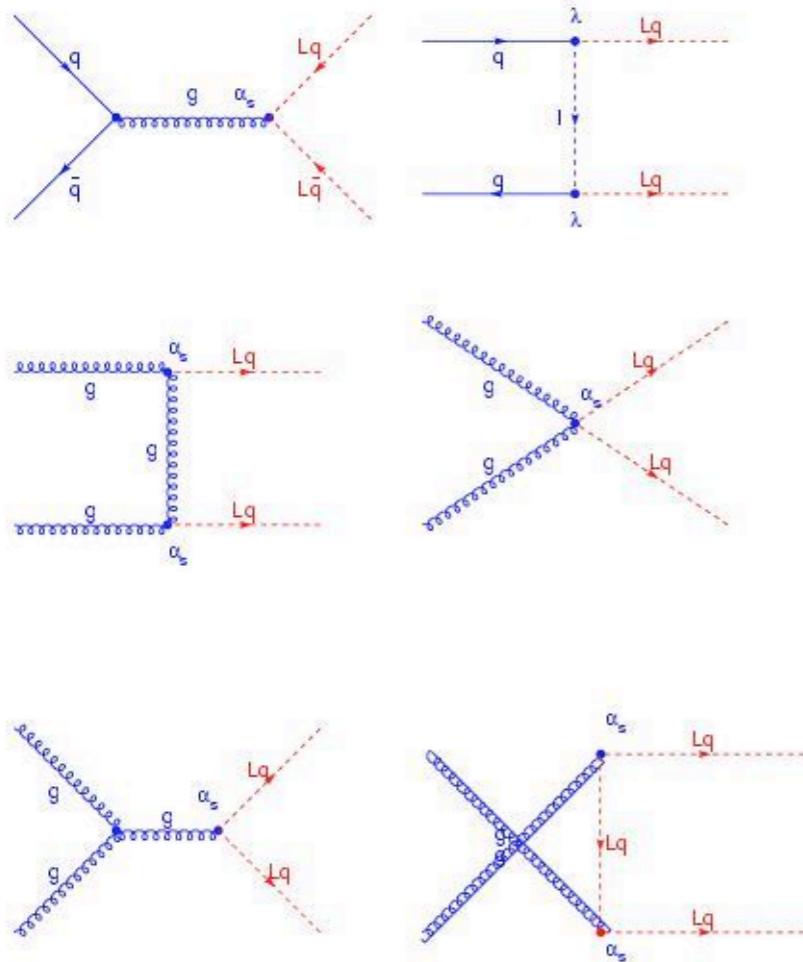
- Signature-based searches
- then, apply to every model you can find!



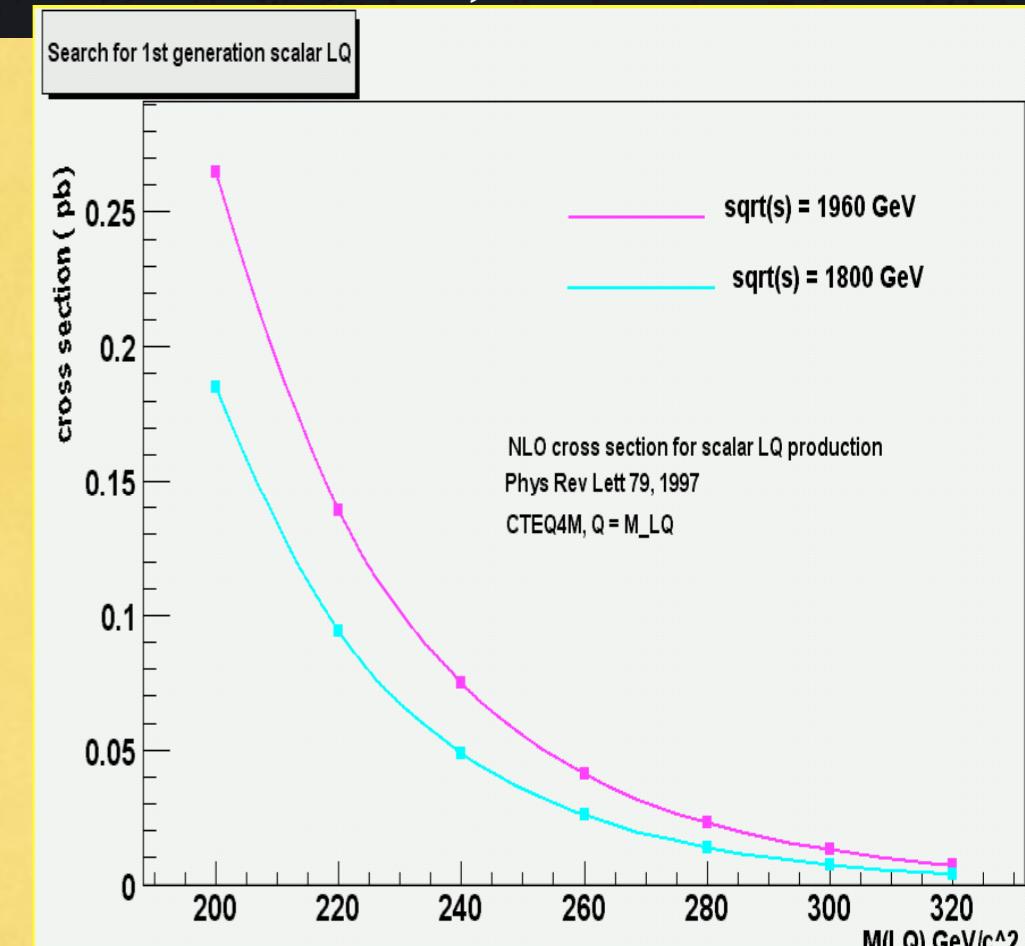
**Run II enhancements: more data,
higher \sqrt{s} , better detector and DAQ**

Leptoquarks @ Tevatron

LQ : color-triplet bosons w/ both lepton and baryon quantum #s, predicted in various BSM theories: Grand Unification, Technicolor, SUSY



Strong pair-production,
cross section
independent of
Yukawa coupling
to I and q, assume
generations don't mix



Search for LQI in Jets+MET

Assume $\text{Br}(\text{LQI} \rightarrow q\nu) = 1.0$

Signature:

MET + 2 high E_T jets

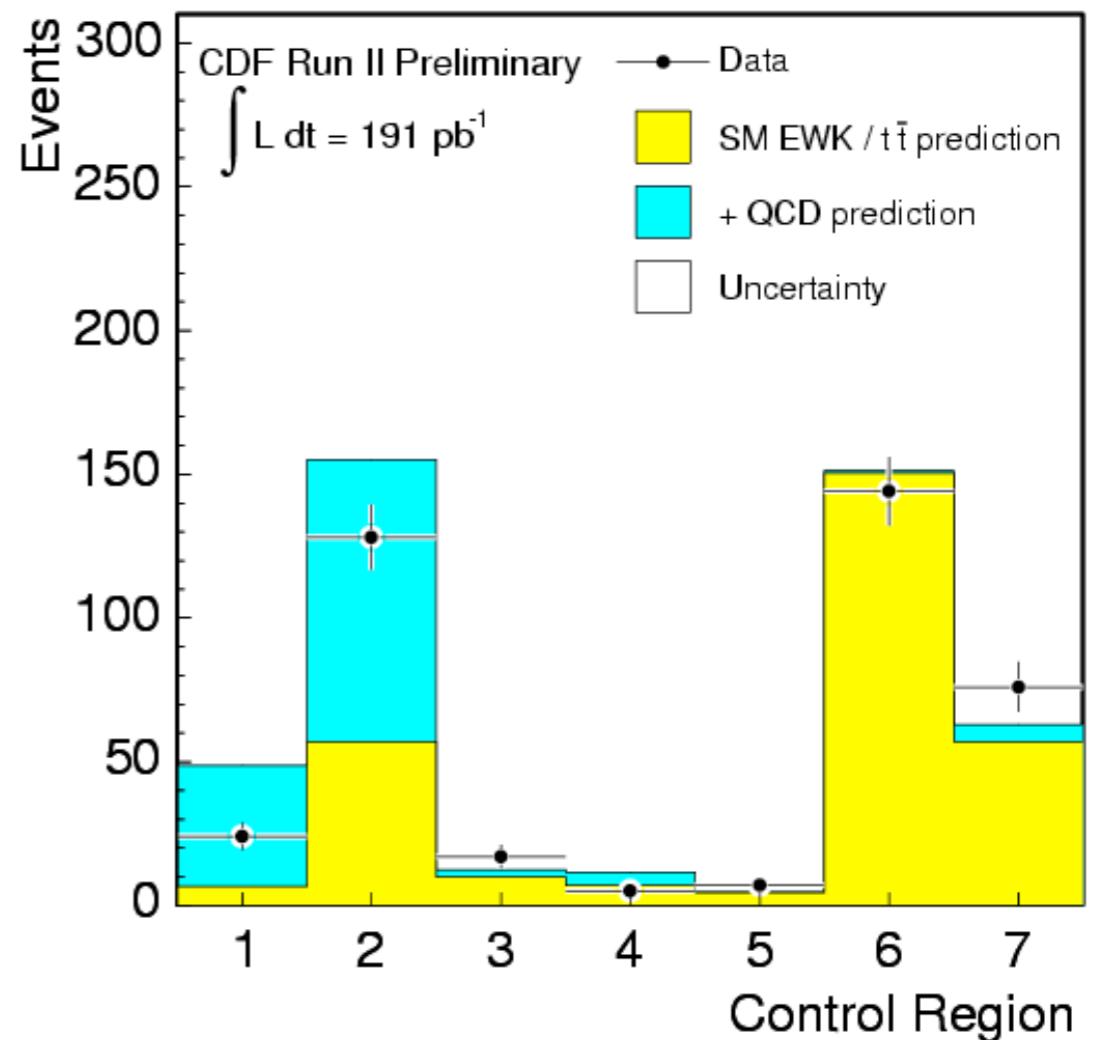
Signal region: MET > 60,
 $80 < d\phi(jj) < 165^\circ$, #leptons = 0

Main backgrounds:
W+jets, Z+jets

Region definition

- | | | | |
|----|--|--------------------------------------|-----------|
| 1) | $45 < \cancel{E}_T < 55 \text{ GeV}$, | $\Delta\phi(j_1, j_2) > 165^\circ$, | $N_l = 0$ |
| 2) | $45 < \cancel{E}_T < 55 \text{ GeV}$, | $\Delta\phi(j_1, j_2) < 165^\circ$, | $N_l = 0$ |
| 3) | $45 < \cancel{E}_T < 55 \text{ GeV}$, | $\Delta\phi(j_1, j_2) > 165^\circ$, | $N_l > 0$ |
| 4) | $\cancel{E}_T > 55 \text{ GeV}$, | $\Delta\phi(j_1, j_2) > 165^\circ$, | $N_l = 0$ |
| 5) | $\cancel{E}_T > 55 \text{ GeV}$, | $\Delta\phi(j_1, j_2) > 165^\circ$, | $N_l > 0$ |
| 6) | $\cancel{E}_T > 55 \text{ GeV}$, | $\Delta\phi(j_1, j_2) < 165^\circ$, | $N_l > 0$ |
| 7) | $45 < \cancel{E}_T < 55 \text{ GeV}$, | $\Delta\phi(j_1, j_2) < 165^\circ$, | $N_l > 0$ |

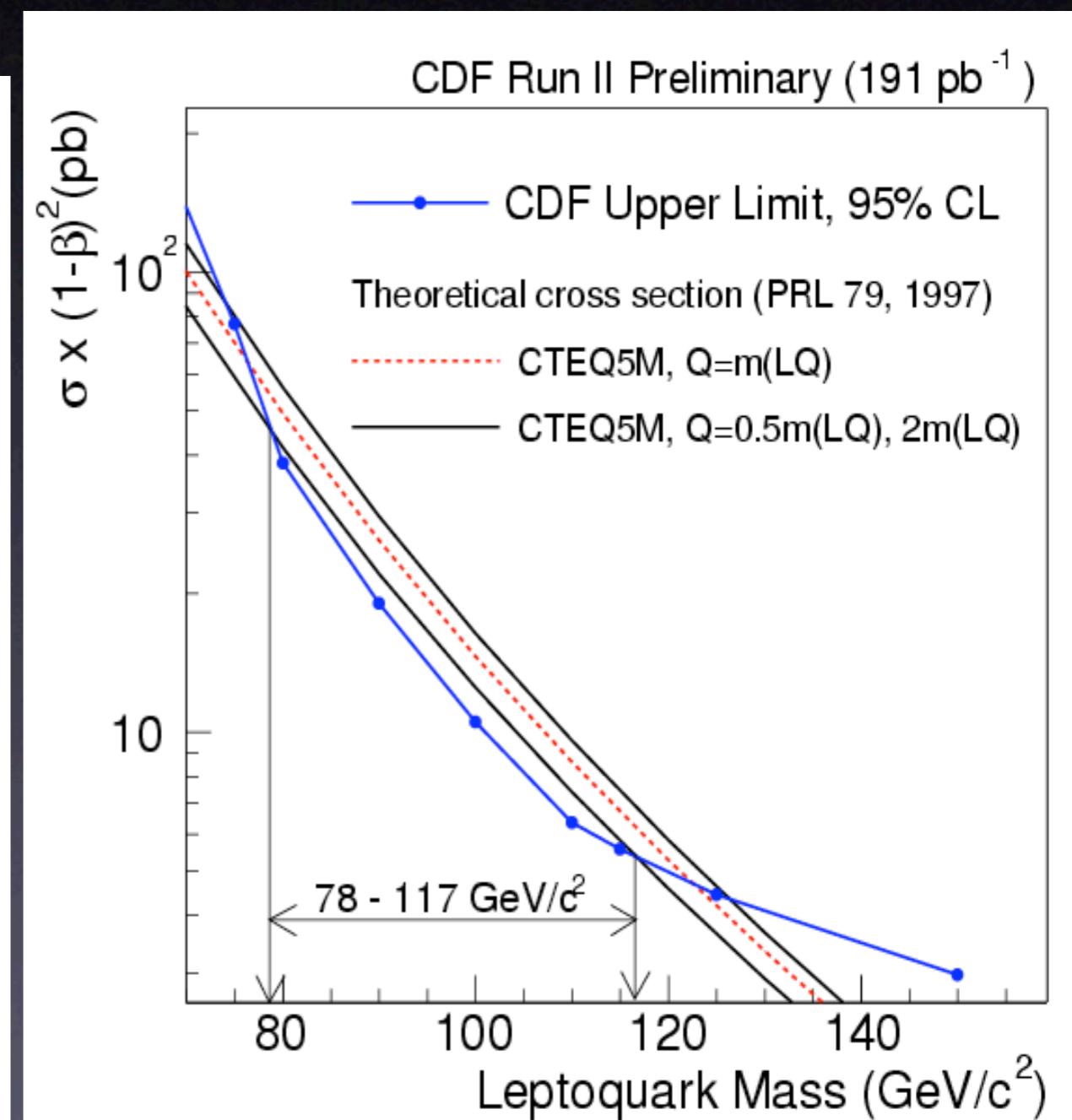
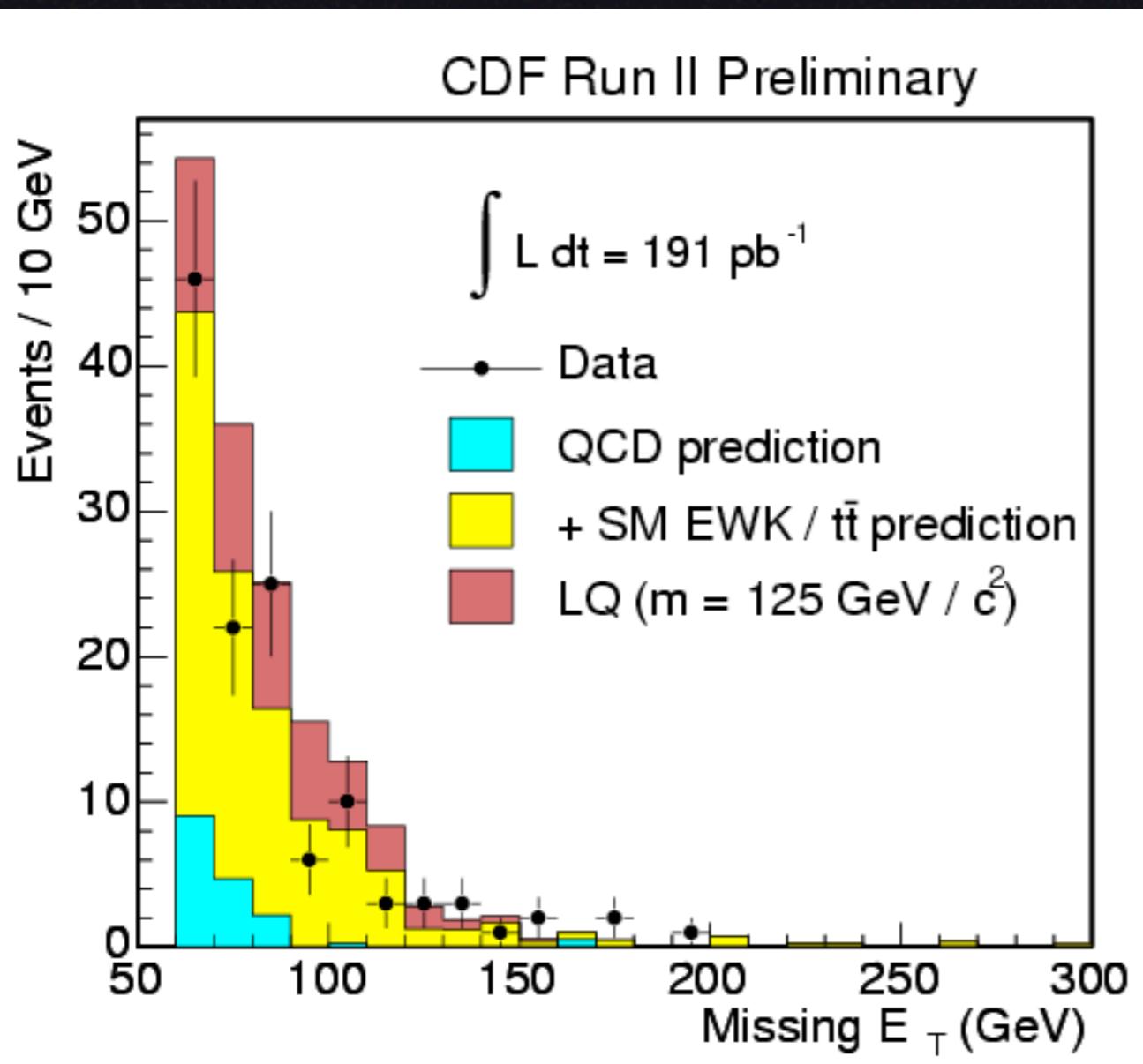
Background Predictions and Data Around The Signal Region



LQ I in Jets+MET (2)

Signal region: 118 ± 14 expected (bg), 124 observed

Compare with NLO prediction & set limits



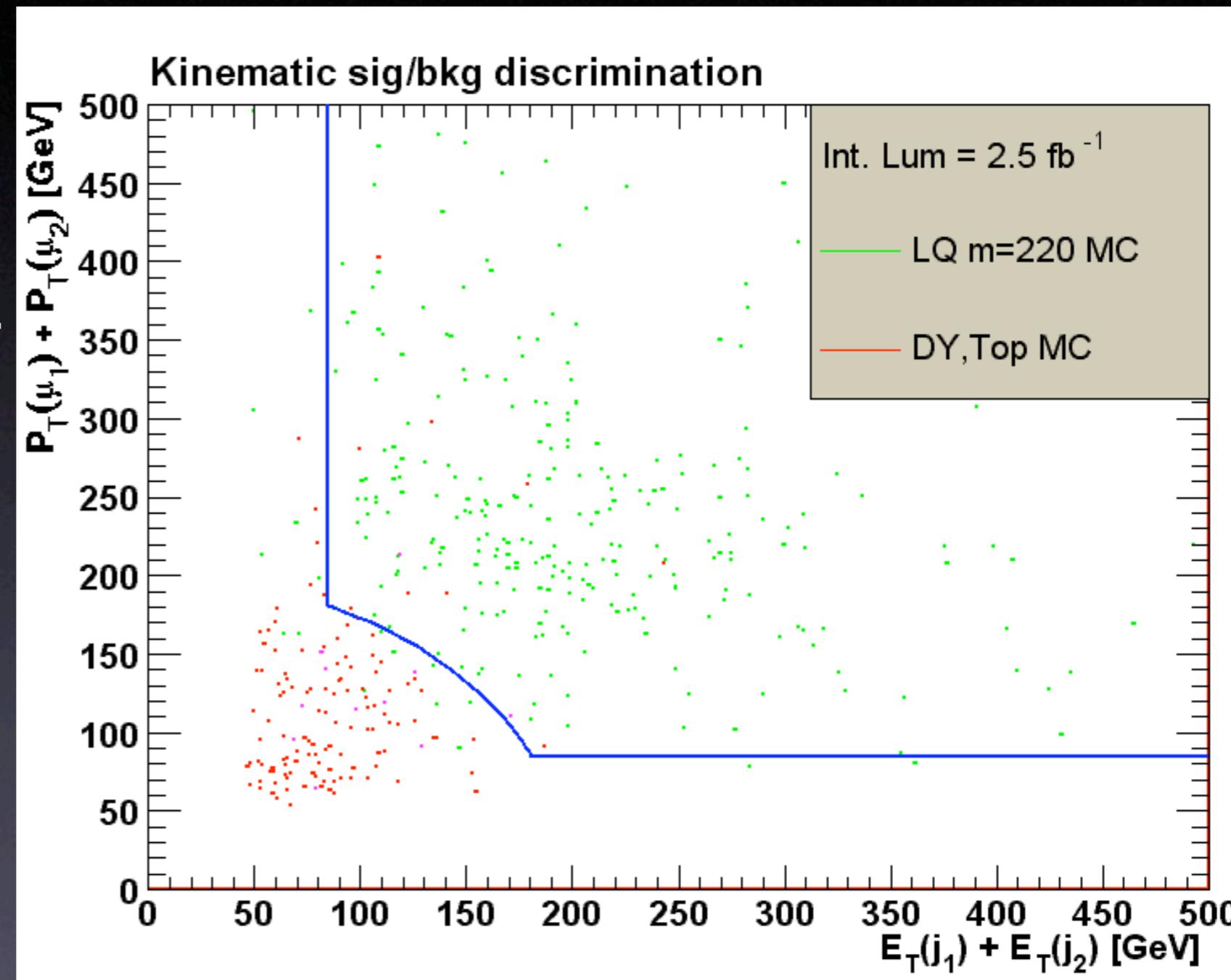
Search for LQ2 in di- μ

- $\text{Br}(\text{LQ2} \rightarrow \mu q) = 1$
- Signature:
dimuons + dijets
- BG: tt, Z+2jets

Kinematical cuts:

$$E_T(j_1) + E_T(j_2) > 85 \text{ GeV} \text{ AND } P_T(m_1) + P_T(m_2) > 85 \text{ GeV}$$

$$\sqrt{(E_T(j_1) + E_T(j_2))^2 + (P_T(m_1) + P_T(m_2))^2} > 200 \text{ GeV}$$



Search for LQ2 in di- μ (2)

Predicted number of
CMUP/CMUP, CMUP/CMX,
CMX/CMX events in 126pb^{-1}

M(LQ)	$Q^2 = M(LQ)^2/4$	$Q^2 = 4M(LQ)^2$
160	13.11	10.44
180	7.54	6.05
200	4.48	3.62
220	2.56	2.06
240	1.45	1.17
260	0.84	0.67
280	0.46	0.36
300	0.26	0.21
320	0.15	0.12

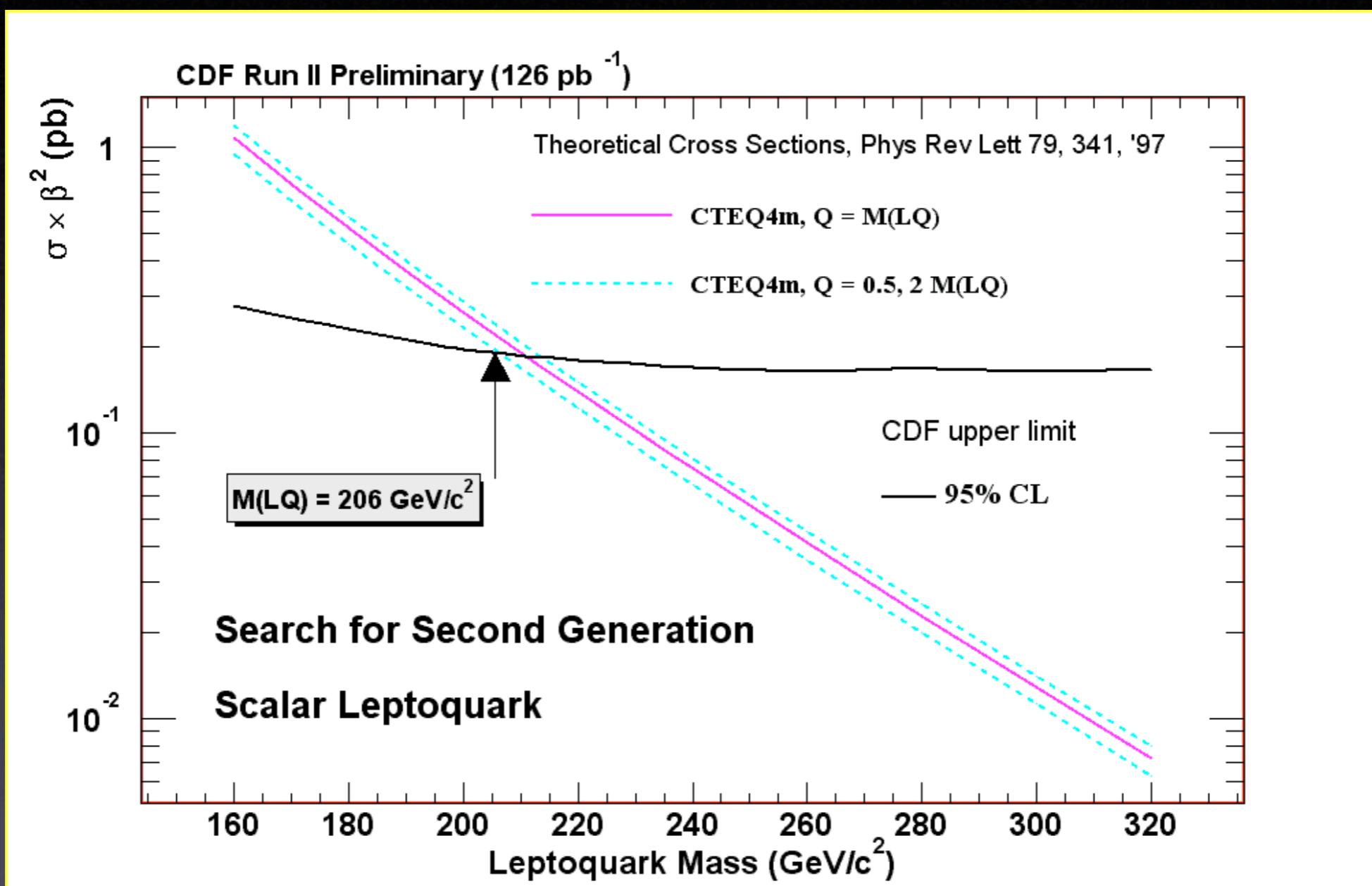
BG: tt, with both $W \rightarrow \mu\nu$: 0.09 events

DY+2jets: 0.34 events

Data

Type of Cut	Tot
Muon ID (2 tight)	1668
$Pt_{\mu 1} & Pt_{\mu 2} > 25 \text{ GeV}$	1561
$E_t j1,j2 > 15,30 \text{ GeV}$	15
$M_{\mu\mu}$ cut	4
$\sum p_{\mu}, \sum p_j > 85 \text{ GeV}$	1
$\sqrt{(\sum p_{\mu})^2 + (\sum p_j)^2} > 200 \text{ GeV}$	0

LQ2 in di- μ Results

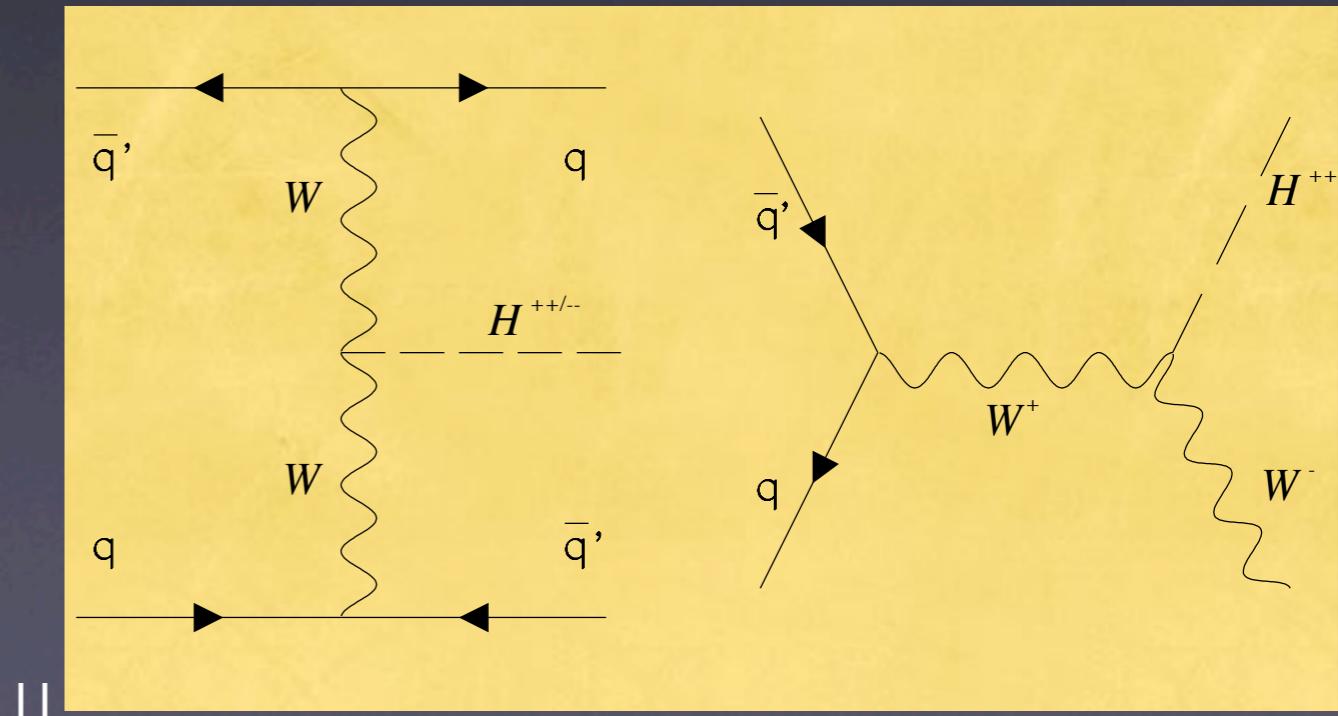
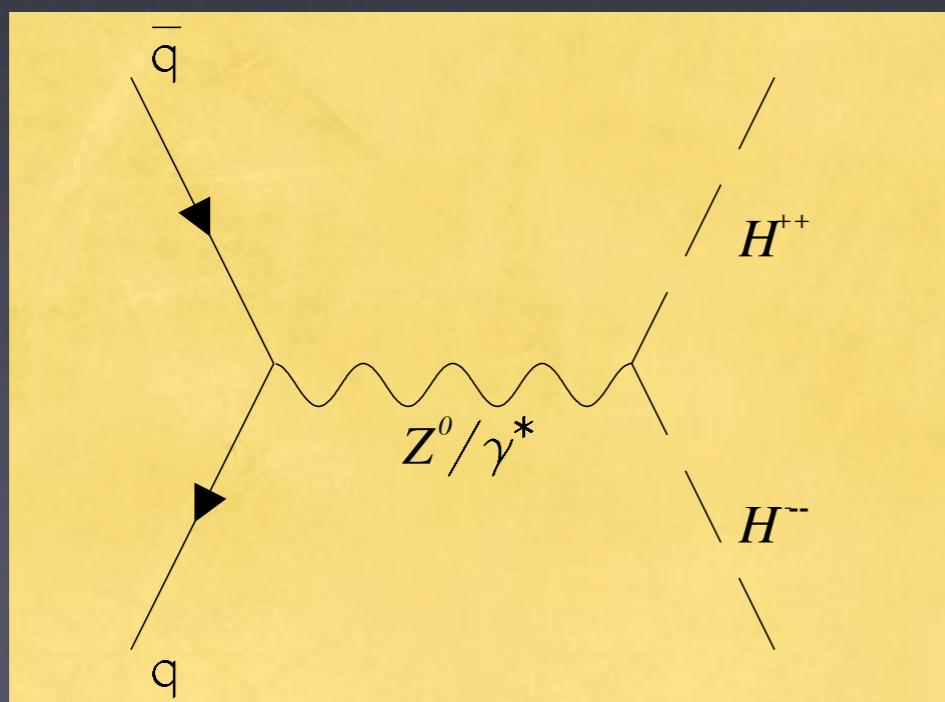


Run I limit: $202 \text{ GeV}/c^2$

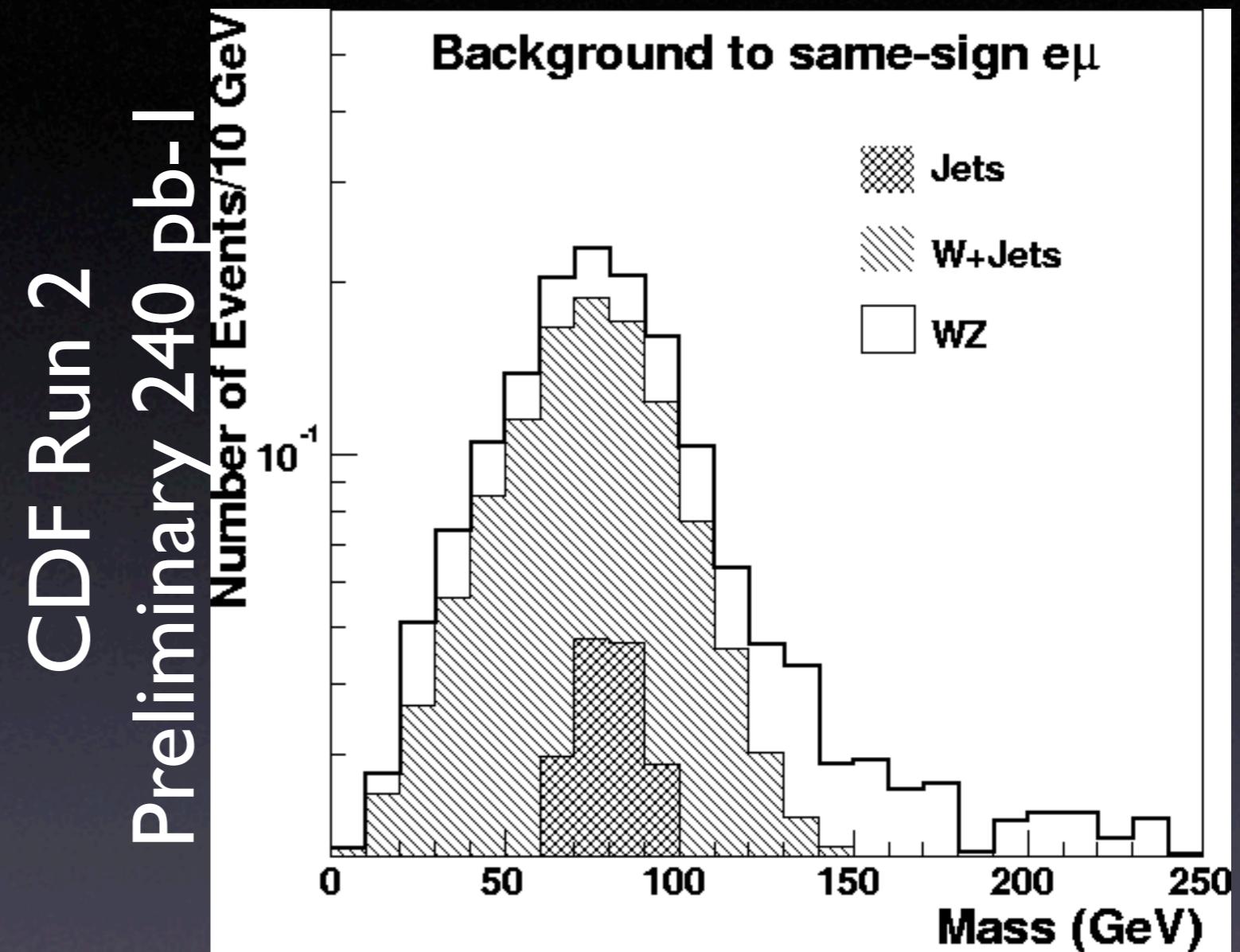
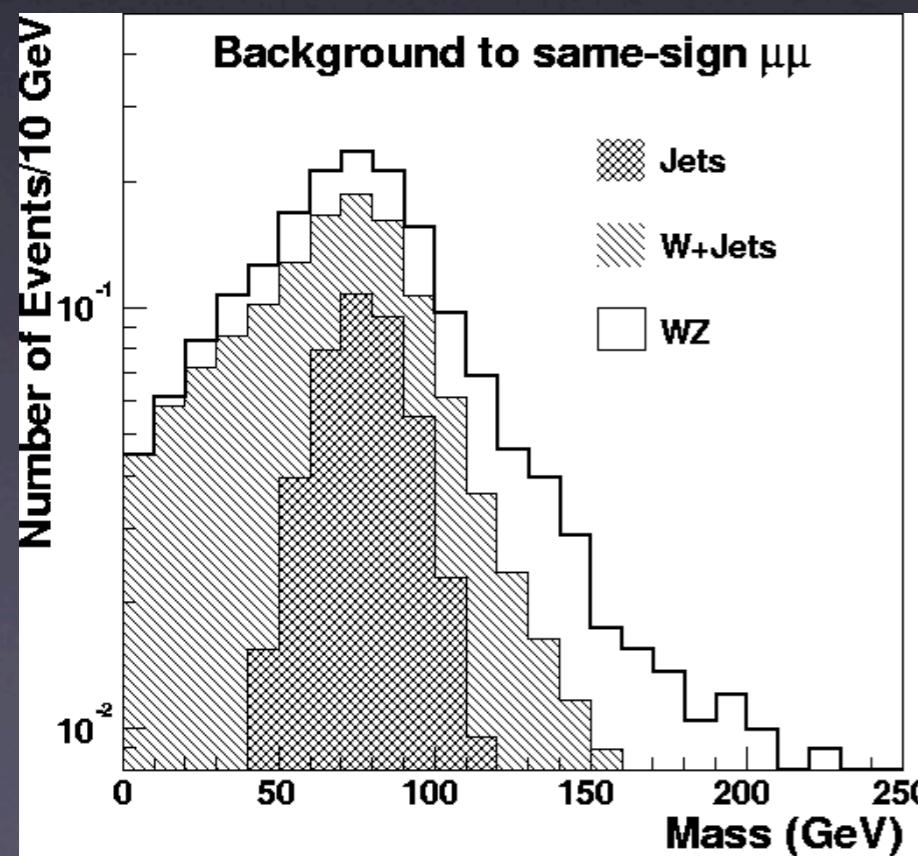
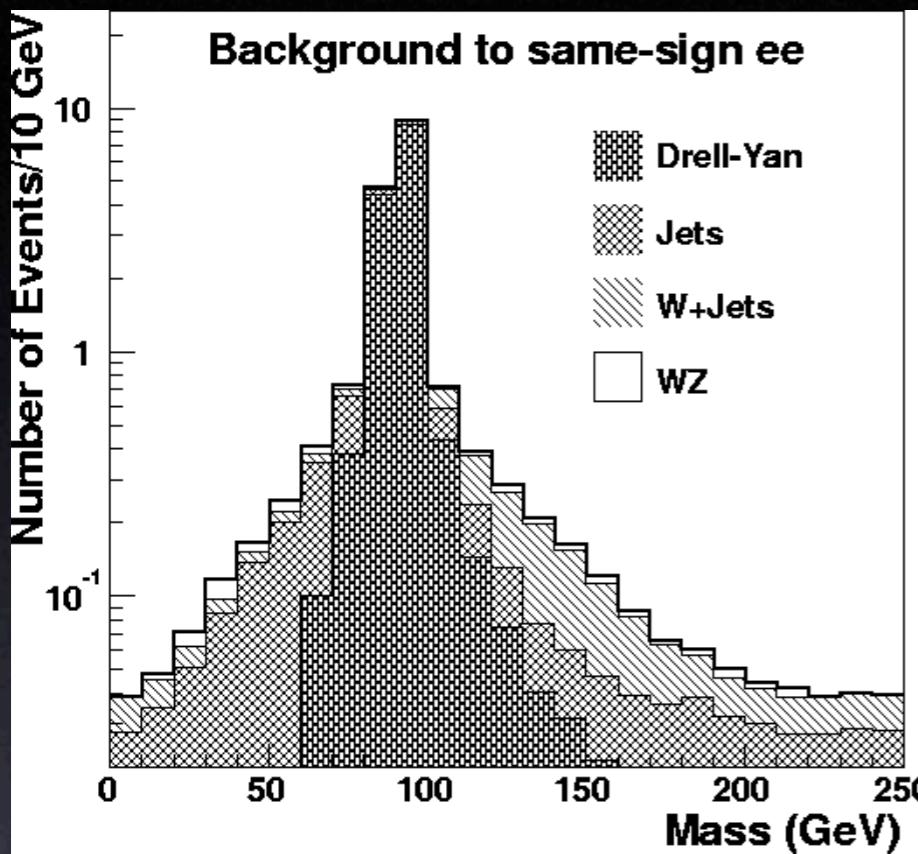
Next: include M1 tracks to increase acceptance

Search for H⁺⁺

- Predicted in left-right symmetric models
- SUSY LR models predict $100\text{Gev} < M(H^{++}) < 1\text{TeV}$
- Search: 240 pb^{-1}
- Strategy: LS dileptons, mass window of $\pm 10\% * M(H^{++})$



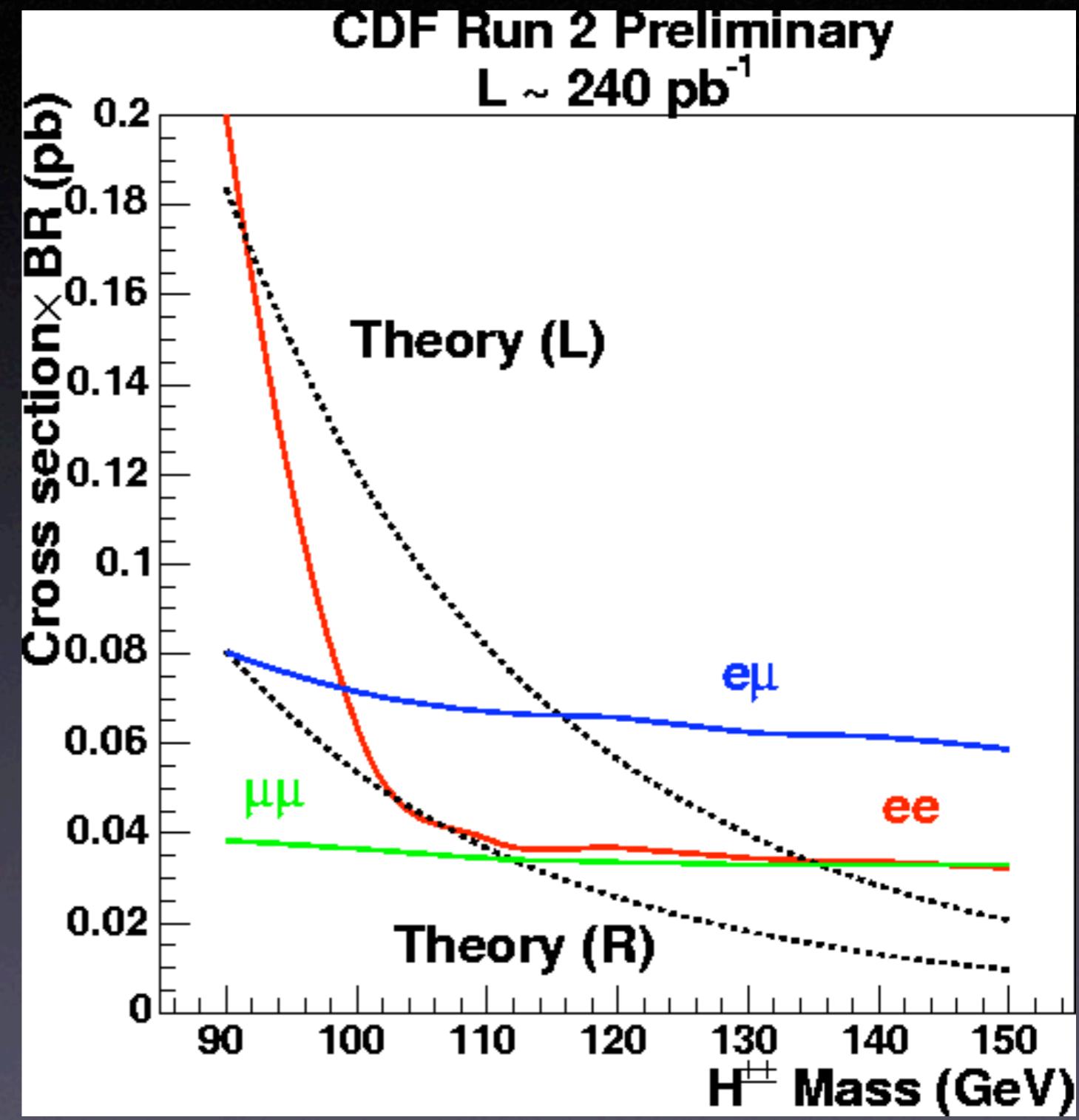
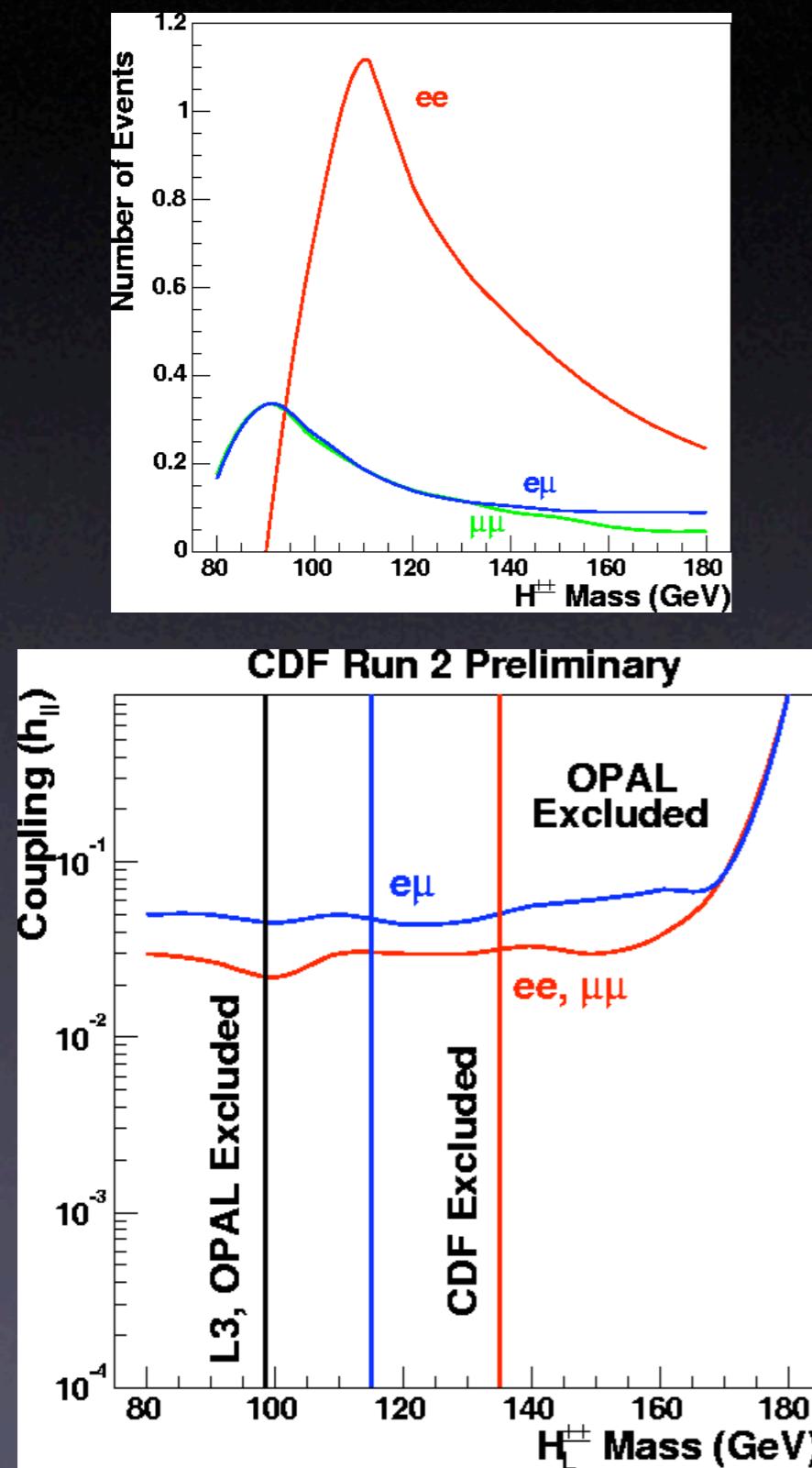
Search for H⁺⁺ (2)



Low mass region: predict 3.4 evts,
obs. 1 ee event

High mass (search) region: 0 obs.

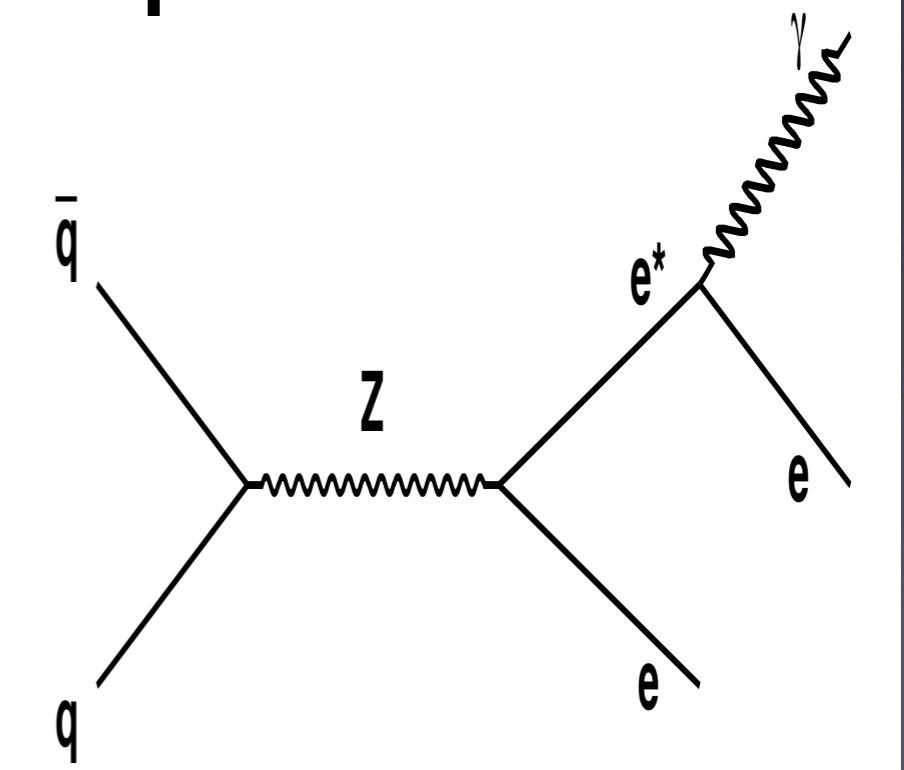
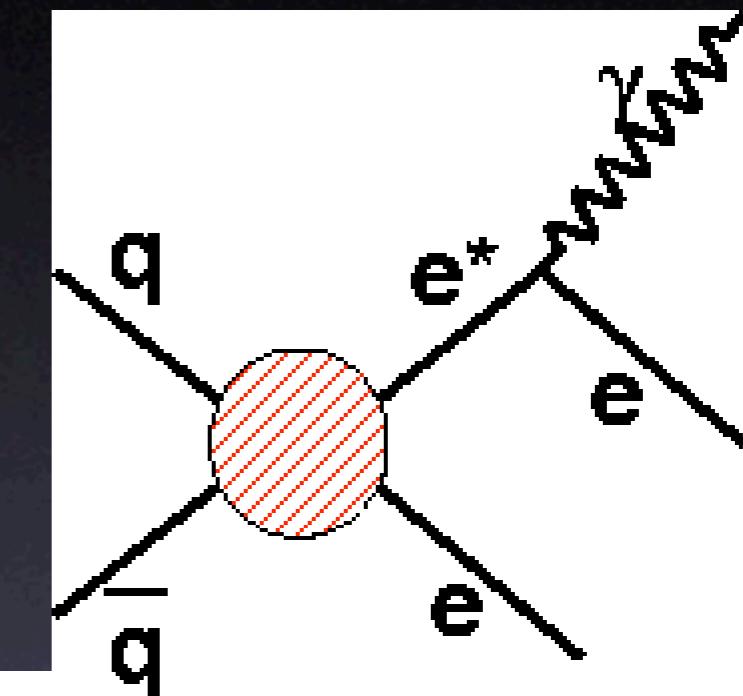
Results for H^{++}



- 135 GeV (ee), 135 GeV ($\mu\mu$), and 115 GeV (e μ) for H_L^{++}
- 110 GeV ($\mu\mu$) and 90 GeV (e μ) for H_R^{++}

Search for excited electrons ($e^* \rightarrow e\gamma$)

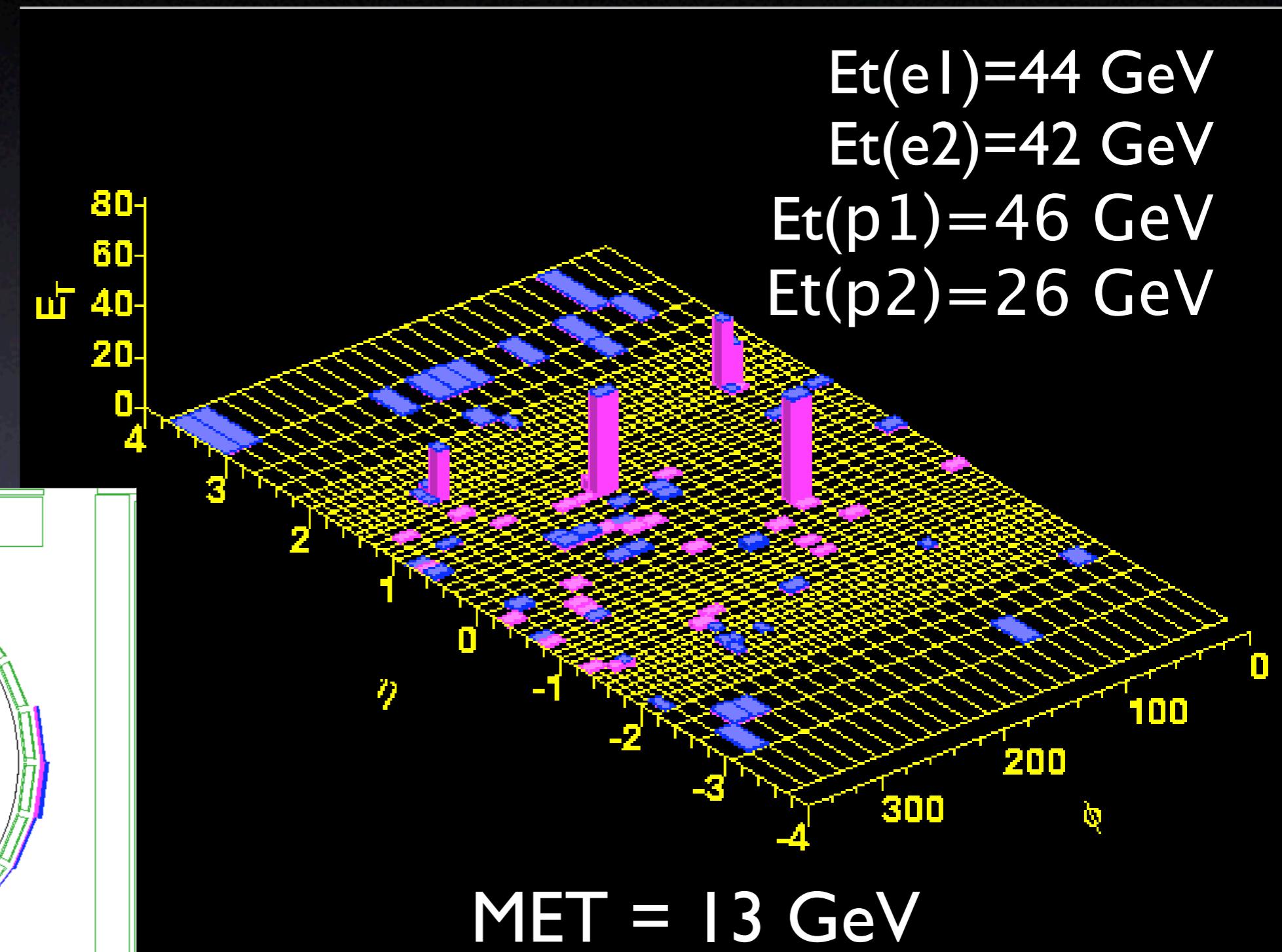
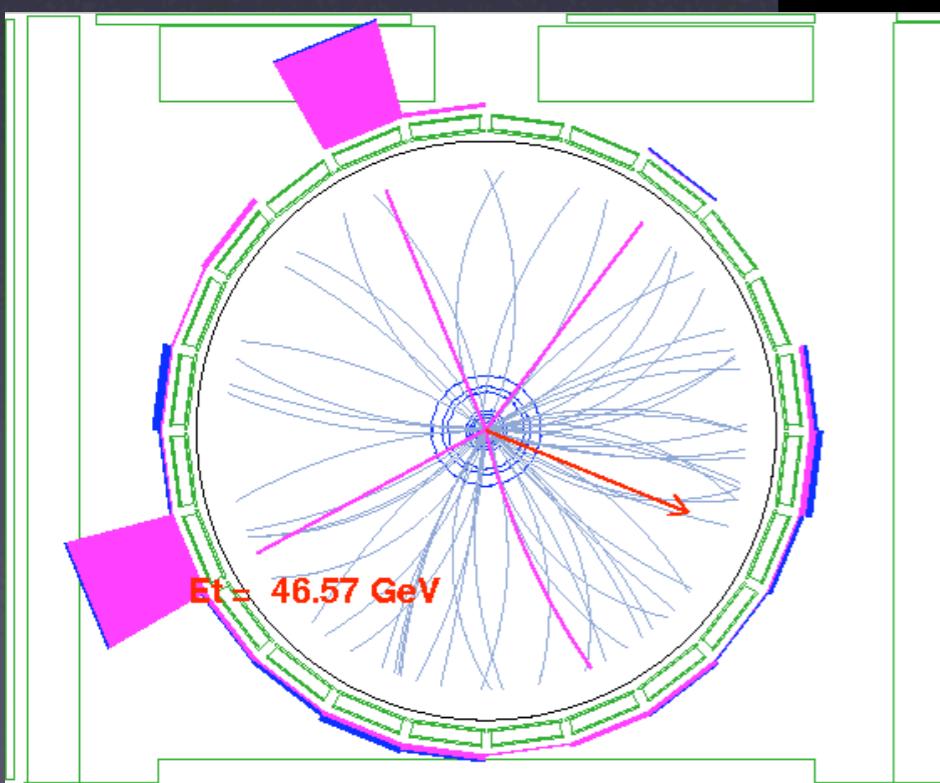
- Examine 200pb^{-1} data for resonance in $e\gamma$ channel
- Effective 4-f Lagrangian, GM e^* models (Baur, Phys Rev D42,3)
- σ depends on $M(e^*)$ and comp. scale Λ



Candidate eeee event

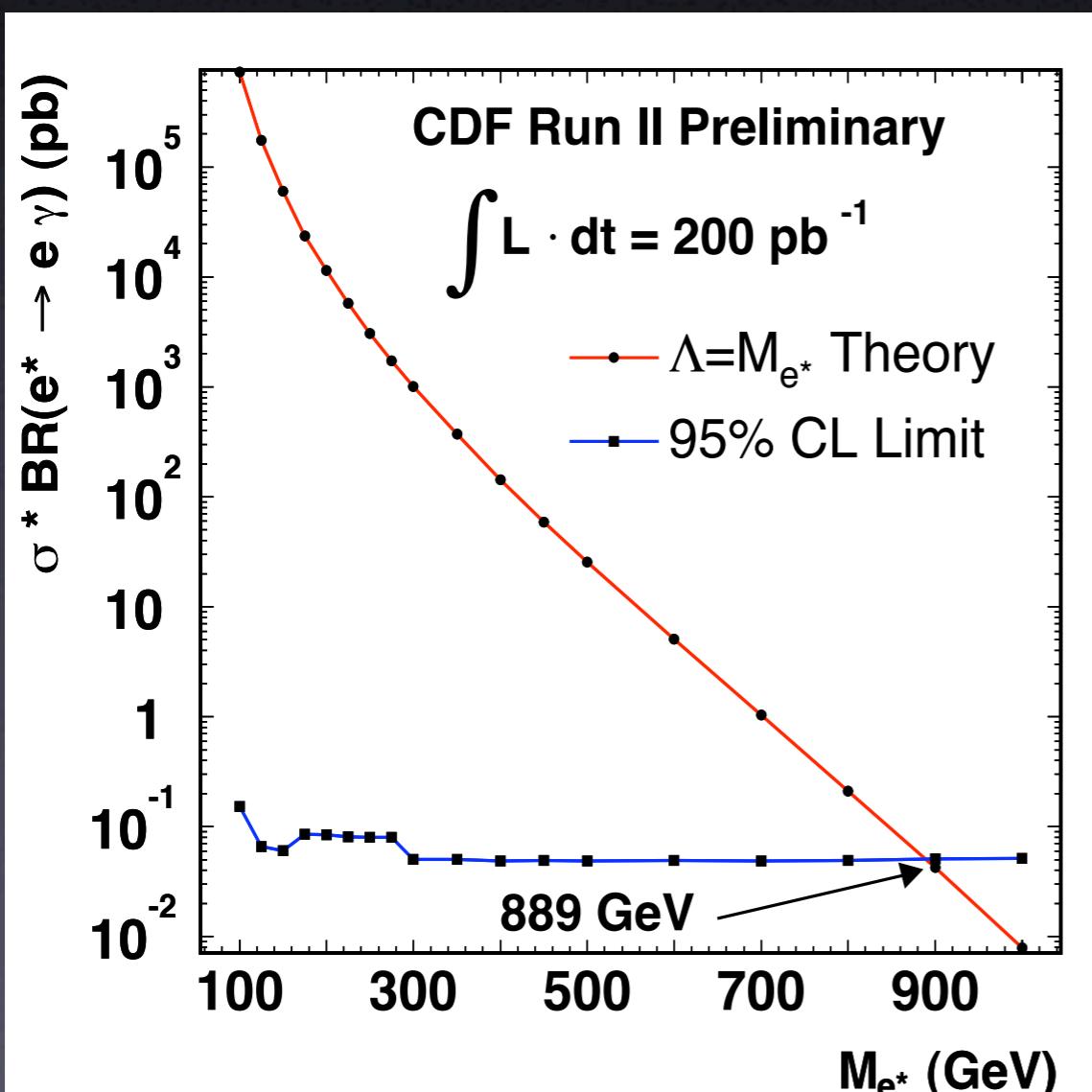
Both p-
objects have
good tracks!

Inv. Masses:
this is ZZ!

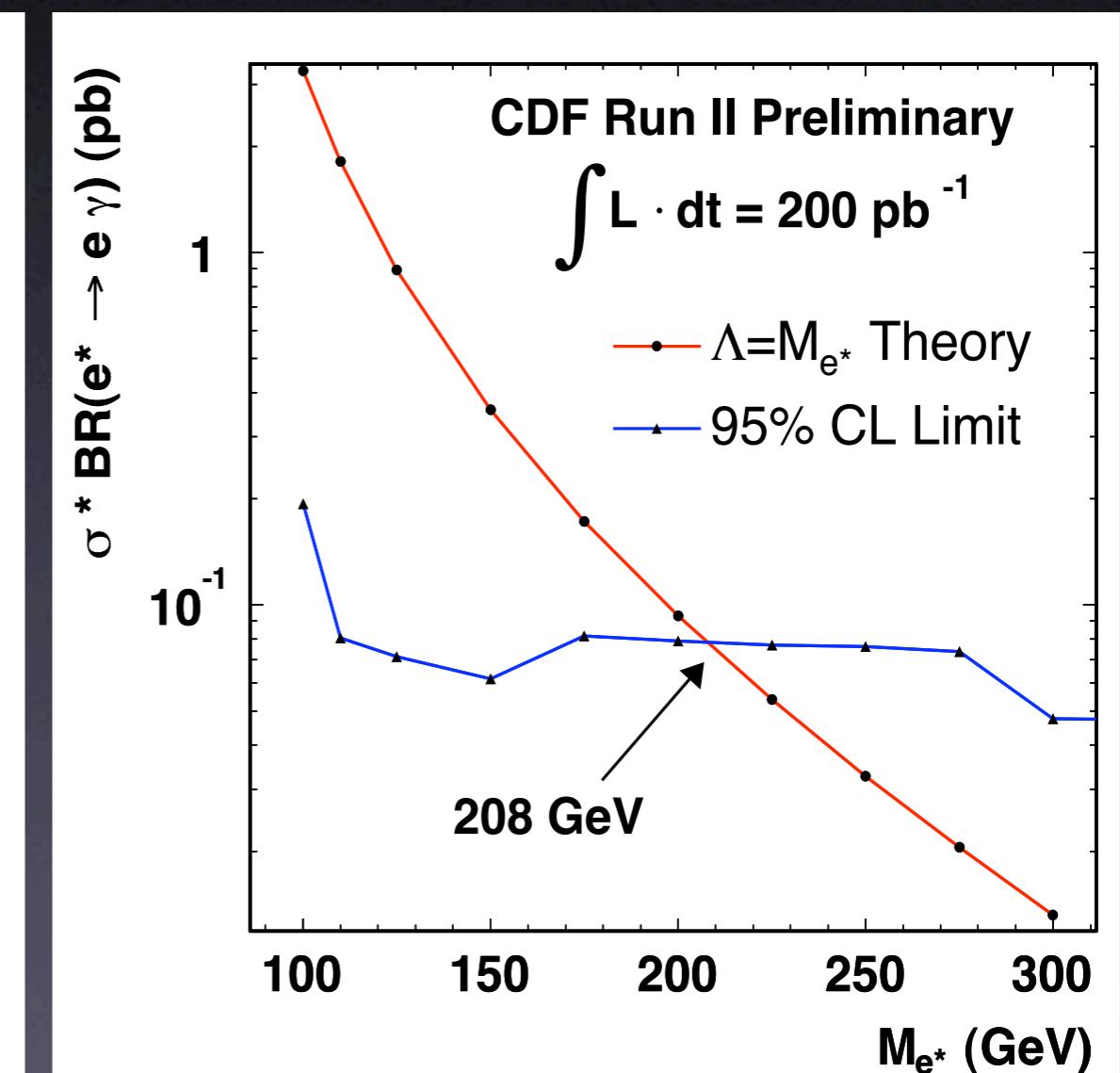


ee γ Results

- Three events observed in 200 pb^{-1} , total expected: 3 events! Set limits on CI, GM



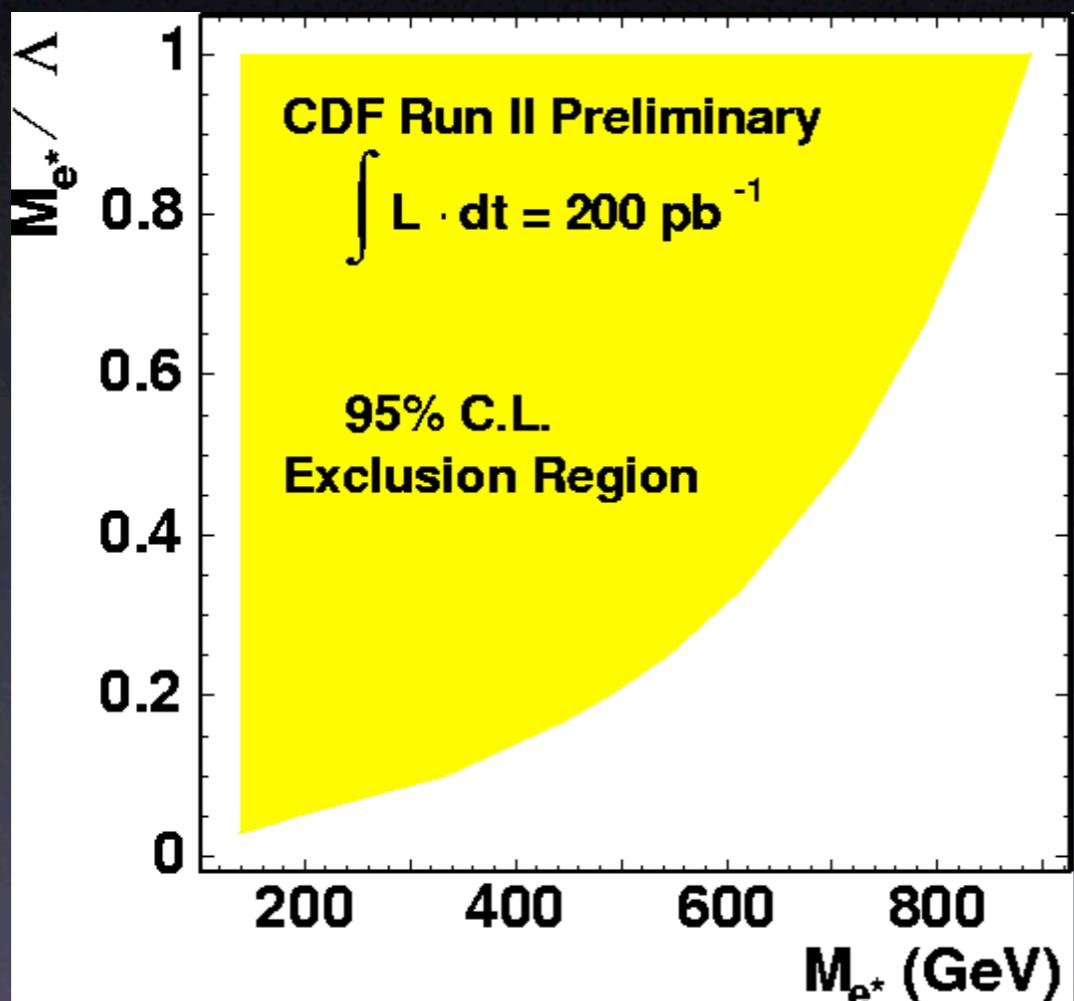
Contact Interaction Model



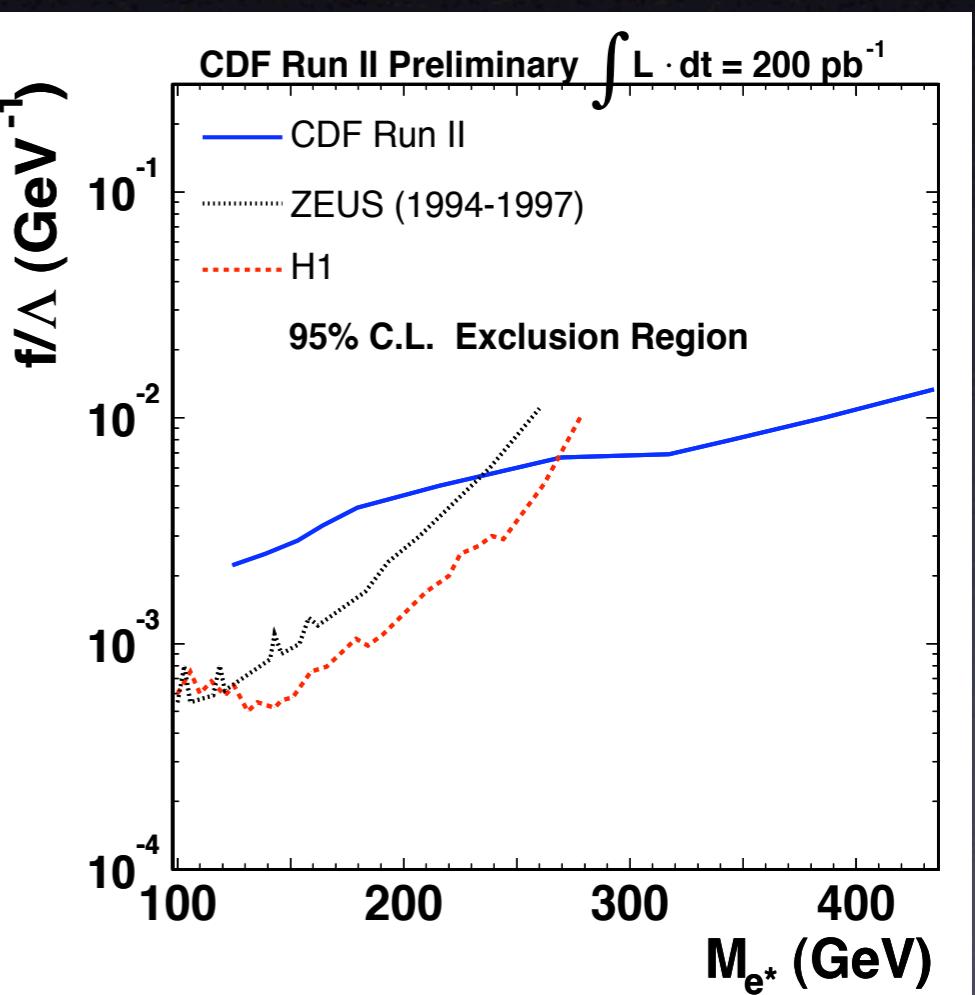
Gauge Mediated Model

ee γ Results (2)

Contact Int. Limits



Gauge Mediated



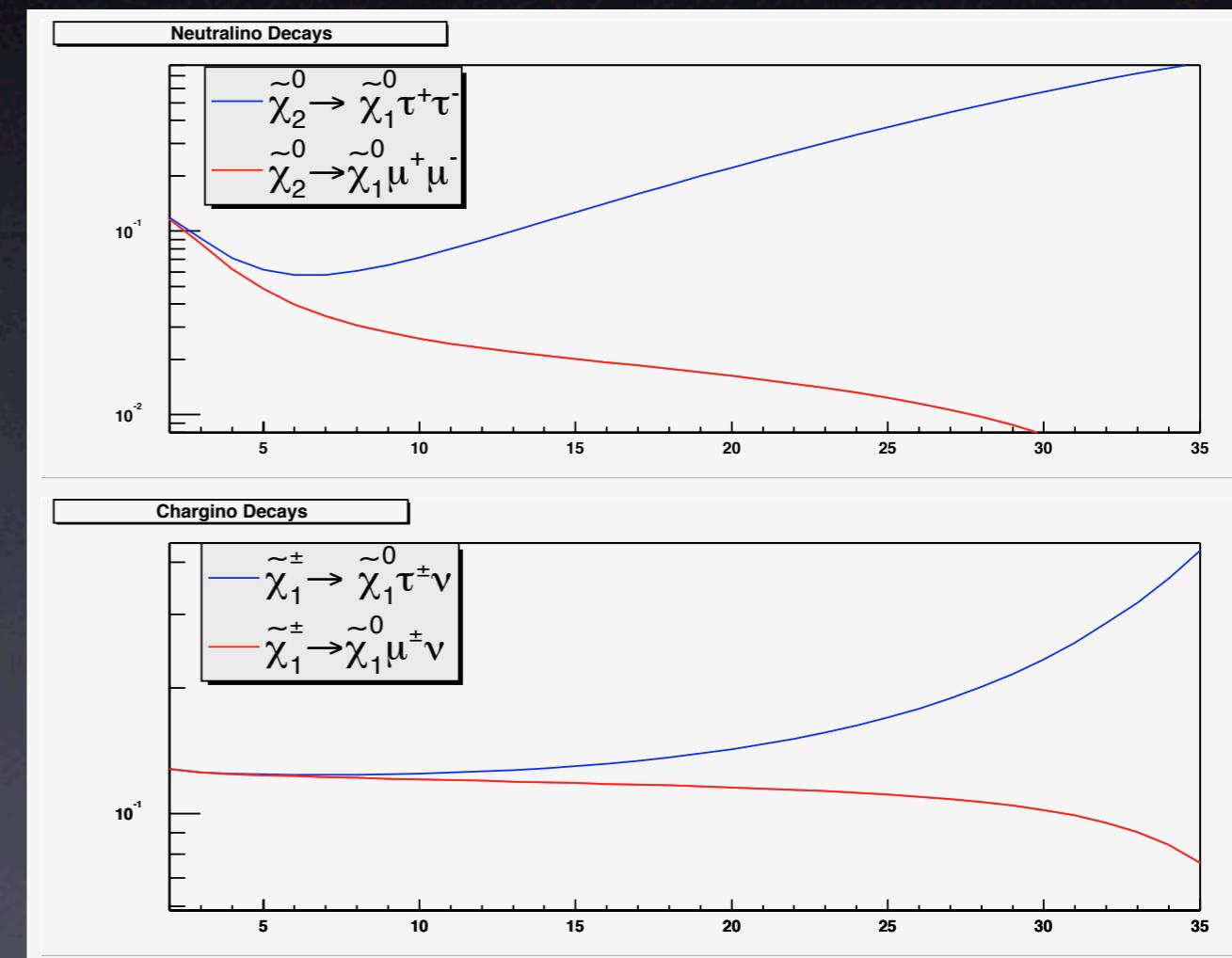
CDF μ^* Results are forthcoming

Other Recent CDF Results

- Z' (See D.Water's talk)
- $X \rightarrow \text{di-jets}$
- scalar- b
- gamma + Missing Et, gamma-gamma
- gamma + heavy flavor
- $B_s \rightarrow \mu\mu$
- CHAMPs

Coming soon from a Collider Detector near you!

- Enhanced LQ2 search with full data set, other LQ decay modes
- Magnetic Monopoles
- $Z \rightarrow \tau\tau$ cross section, $Z' \rightarrow \tau\tau$ search
- SUSY with Tau Leptons!



$\tan \beta$
mSUGRA points: $m_0 = 150$, $m_{1/2} = 150$,
 $A_0 = 0$, $\text{sign}(\mu) = +1$